Medicine Bow National Forest Landscape Vegetation Analysis (LaVA) Project

Air Resources Report

Prepared by:
Melanie Pitrolo
Air Quality Specialist

for:
Medicine Bow National Forest

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Introduction

The purpose of this Air Resource Report is to assess the potential air quality impacts from any air pollution resulting from the Medicine Bow National Forest's Landscape Vegetation Analysis (LaVA) proposed action and alternatives. Air pollution is the presence in the atmosphere of one or more contaminants of a nature, concentration, and duration to be hazardous to human health or welfare. Air quality is a measure of the presence of air pollution. The Clean Air Act sets forth the requirement that the Environmental Protection Agency (EPA) is to establish National Ambient Air Quality Standards (NAAQS) for pollutants that are considered widespread and harmful to public health or the environment. EPA has set NAAQS for six criteria air pollutants: lead (Pb), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), ozone (O_3) and particulate matter (PM). NAAQS apply throughout the United States, although certain pristine areas called Class I Areas are afforded additional protections to ensure that degradation of air quality does not occur.

Resource Indicators and Measures

The proposed Medicine Bow LaVA Project includes a number of vegetation management activities on NFS lands, including inventoried roadless areas, within the Sierra Madre and Snowy Range Mountain Ranges of the MBNF. Specifically, proposed actions including prescribed fire, mechanical, and hand treatment methods could be applied on up to 360,000 acres within the designated Treatment Opportunity Areas (TOAs). Although various vegetation management activities are proposed, not all proposed activities result in air emissions. Thus, this air analysis will only focus on the one proposed action, prescribed burning, that results in an increase in air emissions. This report will address current emissions of air pollutants within the counties where the project is proposed, emissions from the proposed prescribed fire activities, and the ambient air quality concentrations in nearby areas.

Methodology

Existing ambient air quality will be described using information from state-operated monitors located near the TOAs. An emissions inventory will be created for the typical annual burning program and compared to a current inventory of total emissions, compiled by Wyoming state regulatory agencies as well the US Environmental Protection Agency, in order to assess potential impacts to air quality. Finally, emissions from proposed burning activities will be assessed and compared to the total emissions previously described.

Information Sources

Ambient air quality information is available for download at https://www.epa.gov/outdoor-air-quality-data. Emissions inventory information is available for download at https://www.epa.gov/air-emissions-inventories. Emission factor information is available from https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors.

Incomplete and Unavailable Information

None.

Affected Environment

Existing Condition

The proposed project areas lie on the Medicine Bow National Forest, within Carbon and Albany Counties in southern Wyoming. Year-round recreational opportunities abound on the Forest, including hiking, biking, camping, horseback riding, fishing, picnicking, and nature viewing. The Forest is located in a rural setting, with generally good existing air quality.

Emissions from wildland fire include carbon dioxide, water, carbon monoxide, particulate matter, hydrocarbons or volatile organic compounds, and nitrogen oxides. Carbon dioxide and water generally make up over 90 percent of the total emissions. Recently, the Environmental Protection Agency (EPA) has found that greenhouse gas emissions, including carbon dioxide, from motor vehicles contribute to the threat of global climate change. This determination resulted in greenhouse gas emissions from large stationary sources being subject to the permitting requirements under the Prevention of Significant Deterioration (PSD) program. However, at this time, EPA has not begun regulating greenhouse gases from activities such as prescribed fires, and therefore these emissions will not be addressed further in the Air Report.

A brief discussion of the criteria air pollutants and whether they are emitted by prescribed fires is below.

- The lead and sulfur content of forest fuels is negligible, so these two forms of air pollution are not considered further.

- Carbon monoxide is the most abundant pollutant emitted from wildland fire. It is of concern to human health, because it binds to hemoglobin in place of oxygen and leads to oxygen deprivation and all of the associated symptoms, from diminished work capacity to nausea, headaches, and loss of mental acuity. (Details on the health effects of carbon monoxide can be found in Appendix A.) Carbon monoxide concentrations can be quite high adjacent to the burn unit, but they decrease rapidly away from the burn unit toward cleaner air. Carbon monoxide exposure can be significant for those working the line on a prescribed fire, but due to rapid dilution, carbon monoxide is not a concern to urban and rural areas even a short distance downwind. Fortunately, most of the health effects from carbon monoxide are reversible because carbon monoxide is rapidly removed from the body once a person is in cleaner air.

- Nitrogen oxide emissions from wildland fires are very small, and hydrocarbon emissions are moderate. Alone they are not very important to human health, but they are precursors to the criteria pollutant, ozone. Ozone is formed in the atmosphere when nitrogen oxides and hydrocarbons combine in the presence of sunlight. Fire-related NOx and hydrocarbon emissions become more important to ozone levels only when other persistent and much larger pollution sources already present a substantial base load of precursors. To a limited degree, additional intermittent emissions may aggravate an already bad situation. Ozone will be discussed in this analysis.

- The most important pollutant from wildland fire emissions is fine particulate matter ($PM_{2.5}$) due to the amount emitted and the effects on human health and visibility. The term fine particulate refers to particulate matter 2.5 microns or less in diameter. This analysis will address effects of the fine particulate emissions from prescribed fire on air quality within the analysis area.

To understand how the proposed prescribed burning activities might affect air quality, current levels of pollution in the analysis area must be considered. State air regulators are responsible for monitoring air quality. Ambient air quality is described by comparing current pollutant concentrations, as measured by state air regulators, to the National Ambient Air Quality Standards (NAAQS). As mentioned above, NAAQS are threshold concentrations of the six criteria pollutants set by the EPA to protect human health and welfare. The NAAQS are set at conservative levels with the intent of protecting even the most sensitive members of the public including children, asthmatics, and people with cardiovascular disease.

The criteria pollutants of most concern on the Medicine Bow National Forest are particulate matter and ozone. Fine particulate matter is the leading cause of regional haze (also known as visibility impairment), while ozone can harm sensitive vegetation within the forest. Additionally, at elevated concentrations these

two pollutants can impair the health of both employees of and visitors to the National Forest. Although air regulators monitor ozone and fine particulate matter at many locations, there are few monitors located near the TOAs. There are four ozone monitors and only one fine particulate matter monitor located within the vicinity of the proposed TOAs, as shown in the map below.

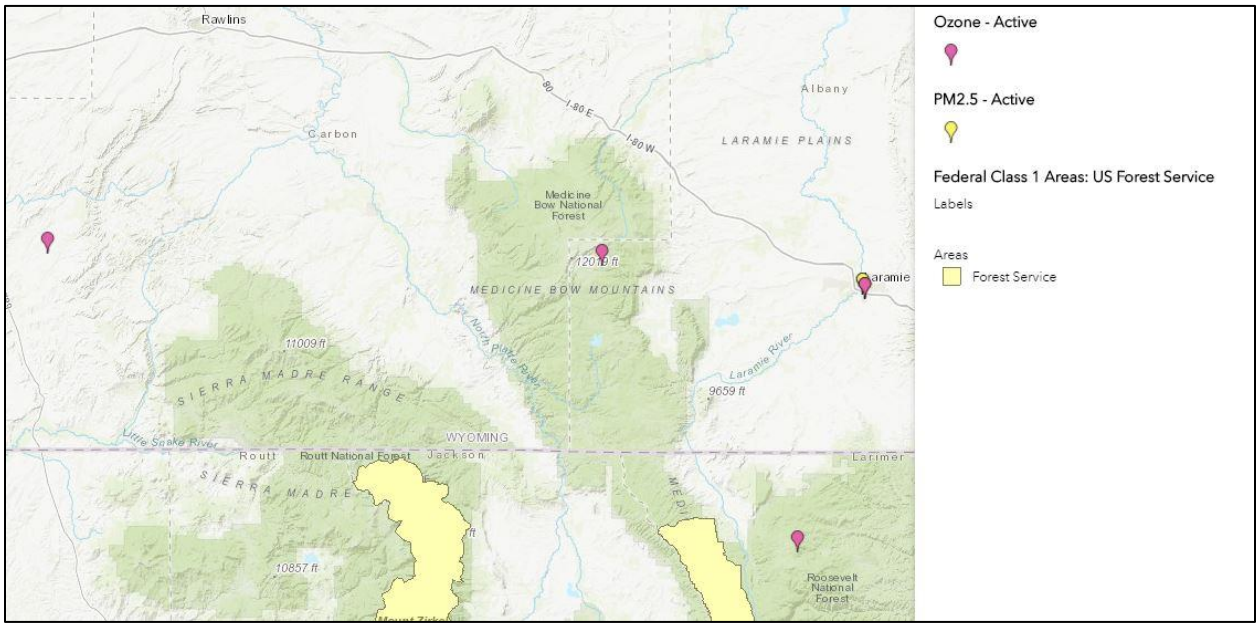

Figure 1. Ozone and fine particulate matter monitoring locations near the Medicine Bow National Forest. Source: https://www.epa.gov/outdoor-air-quality-data/interactive-map-air-quality-monitors

None of the shown monitors have measured values greater than the air quality standards (NAAQS) set by EPA. Additionally, it should be noted that the two counties where this project is proposed are designated attainment for all criteria pollutants, including ozone and particulate matter (source: https://www.epa.gov/green-book). The closest nonattainment area is the Denver Metropolitan Statistical Area (MSA), which is nonattainment for ozone.

The figures below show the existing ambient concentrations of ozone (Figure 2) and fine particulate matter (Figure 3) as measured by ambient air quality monitors near the Ranger District. For both pollutants, only the respective monitors located in Pulaski County, SC were evaluated.

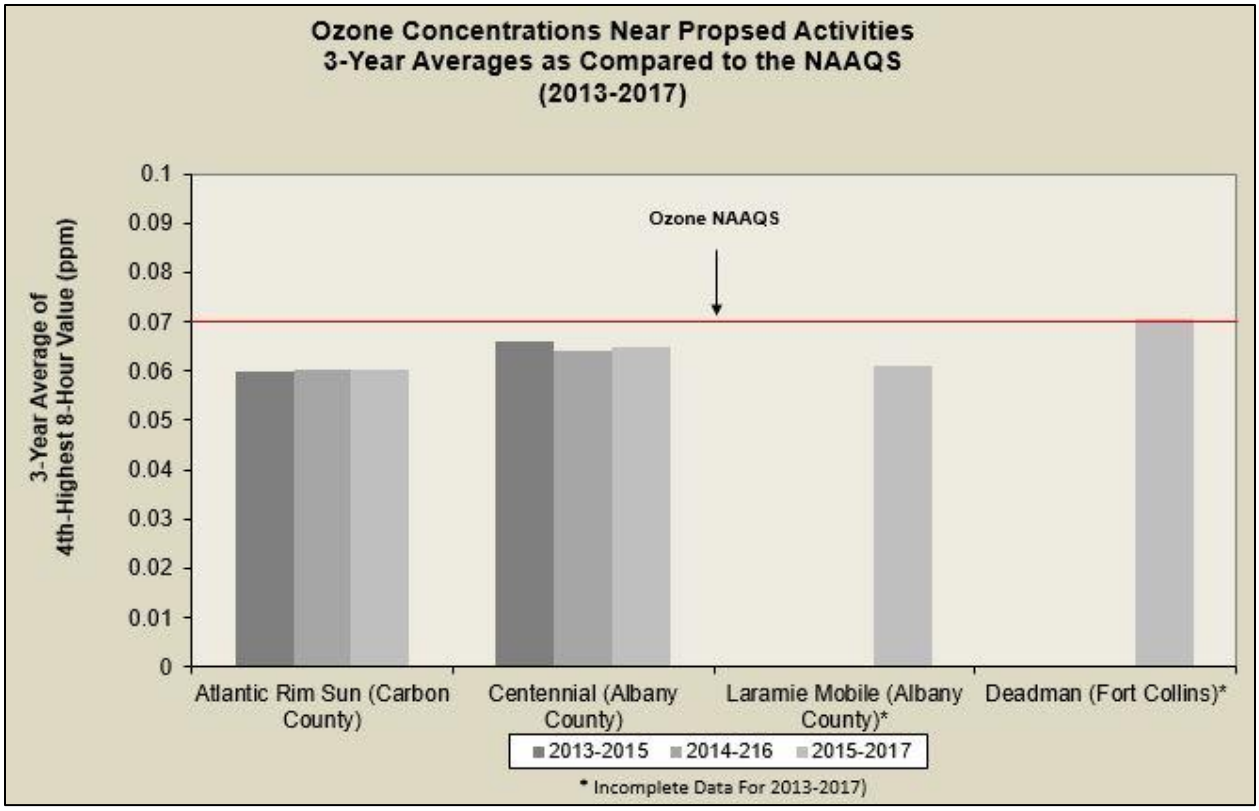

Figure 2. Ozone monitoring results as compared to the current NAAQS. The ozone standard is exceeded if the three-year average of the fourth-highest 8-hour average concentration is greater than 0.070 ppm. Source: https://www.epa.gov/outdoor-air-quality-data/monitor-values-report.

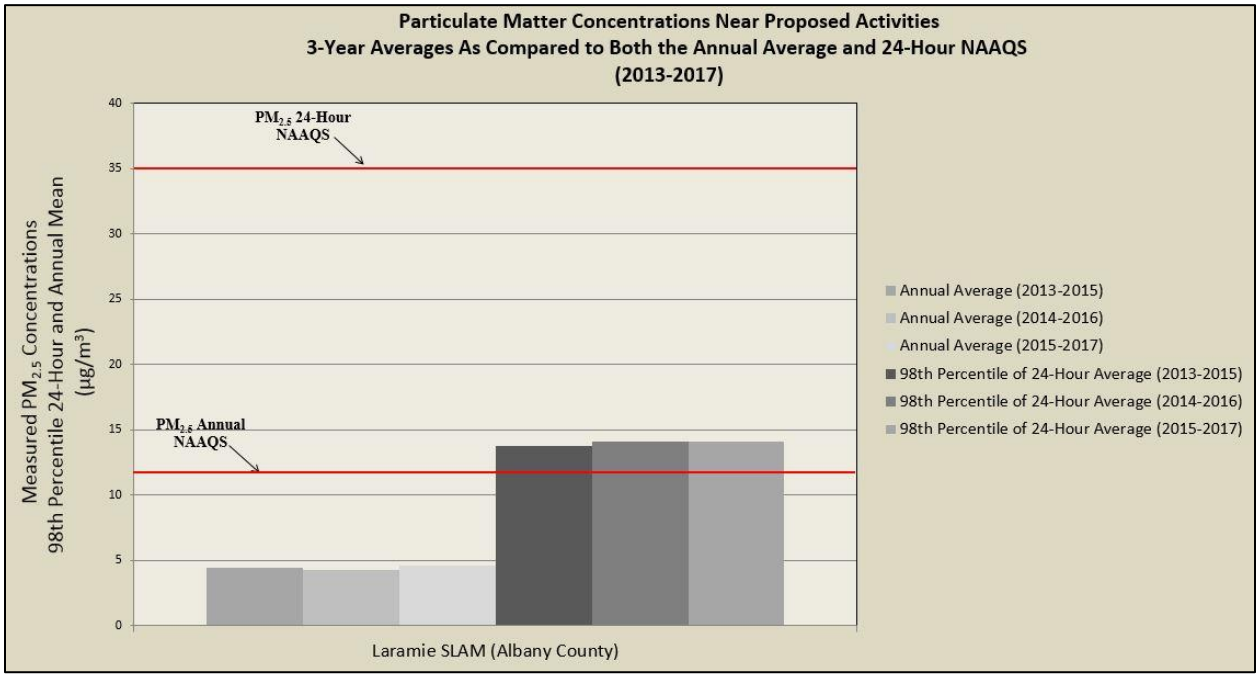

Figure 3. Fine particulate matter monitoring results as compared to the daily and annual NAAQS. The standards are exceeded if the three-year average of the 98th percentile value is greater than 35 µg/m3 (daily) or the three-year average of the annual mean is greater than 12 µg/m3 (annual). Source: https://www.epa.gov/outdoor-air-quality-data/monitor-values-report.

While air quality monitoring describes ambient pollution levels, emissions inventories provide information on the contribution of various pollution sources to total emissions for specific geographic areas. Emissions from prescribed fires are unlikely to be a significant contributor to ozone. Ozone is formed when nitrogen oxides (NOx) and volatile organic compounds (VOCs) chemically react; prescribed fires are usually not a major source of either NOx or VOCs, especially when compared to other air pollution contributors. Most importantly, weather and climate conditions in this area tend to preclude prescribed burning from becoming a significant contributor to ozone formation. Most ozone events occur in mid-spring through late summer when hot temperatures and high-pressure air masses may stagnate over an area, and pollution is not dispersed. Prescribed burning is not typically conducted under these types of weather conditions because of smoke dispersion concerns.

Conversely, fine particulate matter is emitted from prescribed fires and is a contributor to ambient levels of this pollutant.

Table 1 shows the emissions of fine particulate matter within the two counties where the activities are proposed, as well as the emissions from prescribed burning, based on EPA's most recent National Emissions Inventory. Within the counties where prescribed burning is proposed, prescribed fire emissions currently account for 27.3 percent of all fine particulate emissions. Other sources of fine particulate emissions include road dust, mobile sources (vehicles), residential wood stoves, cement manufacturing, fuel combustion and operations at industrial facilities, agricultural activities, and waste disposal.

Table 1: Fine particulate emissions (in tons per year) from the 2014 EPA National Emissions Inventory. Source: https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data

	Fine Particulate Emissions in Tons per Year		
Geographic Area	**From All Sources**	**From Prescribed Fires Only**	**Percentage of Prescribed Fire Emissions to All Emissions**
Albany County, WY	1488	413	27.7%
Carbon County, WY	1785	480	26.9%
Total	***3273***	***893***	***27.3%***

Management Direction

Desired Condition

As a federal agency, the Forest Service must comply with all federal, state, and local laws and regulations concerning air quality. In Wyoming, these include State Implementation Plans for attaining and maintaining national ambient air quality standards (NAAQS) and visibility goals under the Regional Haze Rule, as well as Wyoming's Smoke Management Program. The desired condition for air quality is continued compliance with the NAAQS within the analysis area and minimizing the intermittent impacts of smoke to all sensitive areas.

Environmental Consequences

Alternative 1 – No Action

This alternative would have no immediate (direct) impacts on air quality since no actions would be implemented. Indirectly, this alternative could potentially impact air quality later due to resulting build-up

of forest fuels, which could cause more smoke over longer durations if wildfires were to burn areas not treated.

The cumulative impact of the no action alternative would result from the indirect effects over time on forest vegetation and litter, or "fuel loadings", and the possibility of wildfires. In the absence of prescribed burns brushy species replace grasses and fuel loading increases. Wildfires occurring in areas with increased fuel loadings produce more smoke and are more difficult to contain and therefore often burn for a longer duration. Wildfires may occur at times when wind carries smoke into sensitive areas, and at times when smoke dispersal is poor. The 2014 National Emissions Inventory reports that wildfire emissions in the two counties where the activities are proposed are currently 157 tons of fine particulate matter per year (https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data); increased fuel loadings would likely result in greater annual emissions from wildfires.

Alternative 2 – Proposed Action

A range of vegetation management activities is being proposed as part of the Medicine Bow LaVA Project. Prescribed fire, mechanical, and hand treatment methods may be applied to between 150,000 and 360,000 acres within the designated Treatment Opportunity Areas (TOAs). The total area within the TOAs is 613,109 acres. Because adaptive management will be incorporated, specific treatment areas will be developed and authorized over a 10-15 year period rather than specifying site-specific units and treatments at this time. However, the proposed action does cap the number of acres for specific activities; prescribed fire could occur on up to 360,000 acres although a myriad of other treatment options are likely.

Project Design Features and Mitigation Measures

All prescribed burning that would be conducted under the Medicine Bow LaVA Project will be compatible with the Forest Plan, the desired conditions, and the standards within each management prescription that falls within the project area. The following effects are based on the prescribed fires being implemented in compliance with Wyoming's Smoke Management Standards and Regulations (http://deq.wyoming.gov/aqd/smoke-management/, attached as Appendix B of this document). The general smoke management objectives are as follows:

- Minimize the amount and concentration of smoke entering populated areas;
- Prevent / minimize public health and safety hazards, including
    - Impacts to sensitive sites (schools, hospitals, etc.), and
    - Visual impairment on highways, airports, etc. (both day and night);
- Avoid exceedances of the National Ambient Air Quality Standards (NAAQS); and
- Protect visibility in Class I Areas.

Direct and Indirect Effects

The primary concerns when managing smoke from prescribed burns are impacting surrounding areas. Prescribed fire emissions have a direct, short-term effect on air quality in the project area. These impacts last less than twenty four hours. Once the smoke has dissipated, all impacts are gone. All prescribed burns on the Medicine Bow National Forest are conducted in accordance with the Wyoming Smoke Management Standards and Regulations in order to minimize impacts. The purposes of smoke management programs and guidelines are to mitigate the nuisance (such as impacts on air quality below the level of ambient standards) and public safety hazards (such as visibility on roads and airports) posed by smoke intrusions into populated areas; to prevent significant deterioration of air quality of Class I areas; and to insure that National Ambient Air Quality Standards (NAAQS) are met. Potential smoke emissions from the prescribed burns could be evaluated using the Fire Emissions Production Simulator (FEPS) and the dispersion models VSMOKE and HYSPLIT to estimate direction of smoke dispersion and downwind concentrations prior to implementing the burns. These requirements and guidelines are the

best practices available to avoid and minimize impacts to public health and visibility impairment on highways (safety).

Prescribed fire emissions from the proposed activities would have a direct, short-term effect on air quality in the project area. Once the smoke has dispersed, the impact is gone. The amount of smoke and how it is dispersed depend on the size of the burn, the amount of fuel loading and consumption within the burn unit, and the meteorological conditions at the time of the burn. In general, smoke from prescribed burning disperses into the atmosphere and combines with other existing pollutants. The wind transports the smoke and pollutants to areas many miles away where they are added to and possibly react with other gases/pollutants present in the atmosphere. The fate of emissions from prescribed fires is twofold. Most of the emissions are "lifted" by convection into the atmosphere where they are dissipated by horizontal and downward dispersion from the fire. The balance of the emissions remains in intermittent contact with the ground. Ground level smoke does not have enough heat to rise into the atmosphere. It stays in intermittent contact with the human environment and turbulent surface winds move it erratically. Human exposure to ground level smoke can be more intense, relatively brief (hours rather than days) and limited to a smaller area than exposure from smoke aloft. Smoke aloft is already dispersed before it returns to the human environment while ground level smoke must dissipate within that environment. Ground level smoke is dissipated through dispersion and deposition of smoke particles on vegetation, soil and other objects.

The direct effects of smoke include human health and safety issues. Fine particulates, including those found in wildland fire smoke, affect human health through the respiratory system, although eye irritation is also common. Individuals with cardiopulmonary diseases are especially susceptible. (Details on the health effects of fine particulate can be found in Appendix A.) Residents near the burn unit might have some respiratory discomfort from ground level smoke, however it is expected that most impacts would be in the form of nuisance smoke and/or smell. For example, ash fallout can soil personal property and people may complain about the odors from the smoke. These impacts can be minimized by implementing the burn under weather conditions that are good for dilution and dispersion of the smoke away from smoke sensitive targets.

Fine particulates can also reduce visibility at scenic views by scattering and adsorbing light. A sufficient concentration can result in a reduction in how far a person can see a distant object, and how well a person can see the color and texture of a distant object. Surveys indicate that viewing scenery is an important reason of why people visit National Forests. The visibility impairment caused by the proposed prescribed fires is likely to be short term (less than 24 hours) in duration, and reductions in visibility (distance, color and texture) are likely to decrease as a person moves away from the prescribed fire.

Visibility on roads can be reduced by ground level smoke, causing a safety issue. This can be particularly of concern if smoke continues into the night when emissions are likely to be trapped near the ground and slowly transported from the burned area. The smoke will follow the drainages and collect in low lying areas. In a humid atmosphere the fine particles along with the water vapor released from the fuels can be a primary contributor to the formation of fog, which can become very dense. A person operating a vehicle in the vicinity of the prescribed fire may first experience good visibility conditions and then suddenly have visibility reduced significantly when they drive into the fog formed by the smoldering emissions. Conditions like this can significantly increase the likelihood of highway accidents; however, the likelihood of traffic accidents can be reduced by assisting vehicles driving through the fog or directing the traffic along a different route away from the fog.

The indirect effects of smoke are similar to the direct effects, but are experienced at greater distances from the burn. These effects are usually the result of the “lifted” portion of the smoke. Prescribed fires are managed to disperse and dilute smoke to avoid the negative effects of emissions, especially downwind of

the burn. However, mass ignition techniques (such as aerial ignition from helicopters) that have become more commonly employed in order to treat more acres over a shorter time period can also put more particulate matter into the atmosphere over a relatively short time. Indirect effects last less than twenty four hours. Once dispersion and dilution occurs, the effects are alleviated.

Again, all prescribed burning activities on the National Forest, including those that are proposed in this action, are conducted in accordance with Wyoming's Smoke Management Standards and Regulations in order to alleviate the smoke related impacts outlined above. Smoke management planning has been successful in protecting health and safety during past activities. Each burn unit would be planned in accordance with the Standards and Regulations such that specific parameters are met to ensure air quality impacts are minimized..

Cumulative Effects

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

In addition to using prescribed fire as is proposed, the Forest may also conduct controlled burns in one of the other units or in nearby areas. Depending on the timing of the burns, the NAAQS for fine particulate could be affected. Cumulative impacts will be discussed as they relate to these standards.

Past Actions

Smoke from individual prescribed fires usually disperses quickly (in hours rather than days) and once the smoke has cleared the effect is over. Therefore prescribed burning from several days prior to the current burn event does not contribute to a cumulative effect. However, when prescribed fire is used on closely located burn units over consecutive days, then it is possible to have elevated fine particulate matter over that area over several days. Communication between prescribed fire managers can mitigate this to some extent by planning burns to minimize the number of consecutive days of burning in any particular area. This gives the smoke time to disperse and concentrations of fine particulate to diminish. The Wyoming Smoke Management Standards and Regulations requires notification of all prescribed fires across the state in order to minimize such effects.

Present Actions

Multiple prescribed fires could occur on the same day within the analysis area if burning conditions are favorable, and equipment and staffing are available. Multiple burns, occurring at the same time, could cumulatively increase particulate levels. These short-term impacts are best assessed through smoke dispersion modeling to determine how plumes intersect, the resulting particulate concentrations and the likelihood of exceeding a 24-hour NAAQS. However, at this stage of planning, combinations of burn units that might be treated on the same day are not known and therefore modeling the cumulative impact on the 24 hour NAAQS is not an option. Communication between prescribed fire managers is essential to minimize the chances of smoke from multiple burns merging, whether they are ignited on the same or consecutive days. Additionally and as stated earlier, Wyoming's Smoke Management Standards and Regulations requires notification of all prescribed burns across the state in order to minimize such effects.

Reasonably Foreseeable Actions

No additional impacts from reasonably foreseeable actions are anticipated.

The direct, indirect, and cumulative effects to air quality of the proposed prescribed burning would be of short duration at most (less than 24-hours). As a result of the pre-planning and effective smoke management as required for all the prescribed burn treatment units, the overall magnitude of effects are

well within the standards set to protect public health and safety. No significant cumulative effects would result from implementation of the proposed action.

Regulatory Framework

Land and Resource Management Plan

The Medicine Bow National Forest Land and Resource Management Plan (LRMP) provides goals, standards and guidelines, including those specifically related to air quality. The standards and guidelines that are particularly relevant to this proposed project are listed below.

- **Standards:**

    1. Conduct all land management activities to comply with all applicable federal, state, and local air quality standards and regulations including:

        a. The Clean Air Act (federal), as amended, 1990.

        b. Wyoming Air Quality Standards and Regulations (WAQSR)

    2. Meet requirements of the Prevention of Significant Deterioration (PSD), State Implementation Plans (SIP), and applicable Smoke Management Plans.

- **Guideline:**

    1. Minimize the amount and impact of smoke for each prescribed fire by identifying smoke sensitive areas, using "best available control measures," monitoring smoke impacts, and following guidance in the WAQSR Chapter 10.

Management Area

There are no Federally designated Class I areas, nonattainment areas, or maintenance areas within the counties where the Medicine Bow LaVA Project is proposed.

Federal Law

Clean Air Act

The Clean Air Act and Amendments, among other things, set forth National Ambient Air Quality Standards (NAAQS) for criteria air pollutants, as discussed earlier.

Compliance with LRMP and Other Relevant Laws, Regulations, Policies and Plans

The proposed action, conducted in accordance with the Wyoming Smoke Management Standards and Regulations, complies with the LRMP and all relevant laws, regulations, policies and plans.

Summary

Based on existing air quality information, no long-term adverse impacts to air quality standards are expected from the proposed Medicine Bow Landscape Vegetation Analysis (LaVA) Project. The proposed project includes a variety of vegetation management activities, including prescribed burning, which will be designed to ensure that the Smoke Management Guidelines are followed, and as such the project not threaten to lead to a violation of any Federal, State or Local law or regulation related to air

quality. However, there may be times when smoke from prescribed fires causes short-term respiratory discomfort, is a nuisance, or reduces visibility of those near the burn units. Although burns are planned to minimize these impacts to smoke sensitive areas and nearby residents, there is the potential for the smoke plume to change direction and temporarily affect those in its path. These impacts are short-lived and last less than 24 hours. Impacts may also occur some distance downwind depending on the weather conditions. This is particularly the case for burn units that may contain higher than normal fuel loads due to insect and storm damage, and lack of regular fire treatments. For these reasons, smoke management planning is an integral part of each prescribed burn operation.

Appendix A: Key Regulated Pollutants and their Significance in Smoke

Fine Particulates ($PM_{2.5}$)

Particulate is a term used to describe dispersed airborne solid and liquid particles which will remain in atmospheric suspension from a few seconds to several months. Particulates that remain suspended in the atmosphere are efficient at light scattering and therefore contribute to visibility impairment. Very small particles can travel great distances and contribute to regional haze problems. Regional haze can result from prescribed burning over multiple days and/or multiple owners utilizing the air shed over too short a period of time. Cumulative particulate load may be the result of prescribed burning only, or urban and industrial sources only, or it may be a combination of the two. The causes of regional haze are often difficult to identify. Total suspended particulates (TSP) include all suspended particulates, no matter the size. Particulate matter less than 2.5 microns in diameter (PM2.5), or less than 10 microns in diameter (PM10) describes particles small enough to enter the human respiratory system. Fires emit large amounts of fine particulate matter that can affect human health and impair visibility.

Particulate matter, alone or in combination with other pollutants, can constitute a health hazard. Particulates enter the body mainly via the respiratory system. Particulate matter may exert a toxic effect in one or more of the following ways:

1. The particle may be intrinsically toxic because of its chemical and/or physical characteristics.
2. The particle may interfere with one or more of the mechanisms that normally clear the respiratory tract.
3. The particle may act as a carrier of an absorbed toxic substance.

Medical studies have shown a solid relationship between increases in particulate concentrations and rises in the number of clinic and hospital visits for upper respiratory infections, cardiac diseases, bronchitis, asthma, pneumonia, and emphysema. Deaths of elderly persons afflicted with respiratory diseases and cardiac conditions also show an increase during periods when the concentration of particulate matter is unusually high for several days.

Some recent studies have indicated that urban particulate matter may be more dangerous to human health than rural particulate. There is speculation that urban pollution sources, like auto exhaust and industrial sources may be more toxic than rural sources, such as dust or wood smoke. This theory has not yet been proven definitively.

There are few studies that evaluate the toxicity of forest fire smoke. Almost all investigations of the toxicity of smoke particulate matter in human populations have been conducted with particulates associated with burning coal or fossil fuels where sulfur oxides and sulfates are the important constituents. However, these chemicals are not generated in a significant quantity by vegetation fires.

Sulfur Dioxide

Sulfur dioxide (SO_2) is emitted primarily from combustion of fuel containing sulfur; generally either coal or oil. Sulfur compounds are also emitted naturally by marine sources, soils and vegetation, volcanoes, and geothermal activity. Humans respond to sulfur dioxide exposure with an increase in airway resistance. Most individuals show a response to SO_2 at concentrations of 5 ppm (parts per million) and above and certain sensitive individuals show slight effects at 1 to 2 ppm. Excess SO_2 in the atmosphere also effects sensitive vegetation.

Sulfur dioxide can also contribute to reduction in visibility. Atmospheric haze is caused by the formation of various aerosols resulting from the photochemical reactions between SO_2, particulate matter, oxides of nitrogen, and hydrocarbons in the atmosphere. Sulfur dioxide transforms into an acid when absorbed in cloud water and raindrops and can fall as acid rain.

Most forest fuels contain less than 0.2 percent sulfur so sulfur oxides could be produced only in negligible quantities during prescribed fires and wildfires.

Carbon Monoxide

Carbon monoxide (CO) is produced by automobile exhaust and other incomplete combustion sources. Carbon monoxide is a poisonous inhalant that deprives the body tissues of necessary oxygen. Extreme exposure (>750 ppm) can cause death. Impaired time-interval discrimination can occur when humans are exposed to concentrations as low as 10 to 15 ppm for 8 hours. Carbon monoxide exposure can also result in central nervous system effects such as impairment of visual acuity, brightness discrimination, and psychomotor functions. Symptoms include headache, fatigue, and drowsiness.

Large quantities of carbon monoxide are emitted from wildfire and prescribed fires. Carbon monoxide exposure from these sources can be significant for fire line workers but CO dilutes very rapidly in the atmosphere and probably is not a concern to urban and rural areas even a short distance downwind. One study measured CO concentrations as high as 200 ppm close to flames but observed that the concentration was reduced to less than 10 ppm just 100 feet from the fire.

Ozone

Ozone is a secondary pollutant formed from the reaction of volatile organic compounds with oxides of nitrogen in the presence of sunlight. Volatile organic compounds originate from industrial processes, solvent use, and transportation. The origin of nitrogen oxides is discussed in another section. Ozone can cause eye, nose, and throat irritation, and chest constriction in humans at concentrations above 0.10 ppm.

On vegetation, ozone can cause visible injury, reduced photosynthetic capacity, increased respiration, premature leaf senescence, and reduced growth. Other effects include alteration of carbon allocation, greater susceptibility to environmental stress, changes in plant community composition, and loss of sensitive genotypes from a population.

Prescribed fires and wildfires emit volatile organic compounds (VOCs) which can react with urban sources of nitrogen to form ozone. Elevated ozone levels have been measured at the top of smoke plumes. Elevated ozone in cities far downwind from wildfires has been attributed in part to wildfire emissions.

Nitrogen Dioxide

Oxides of nitrogen are formed in a combustion process when nitrogen in the air or in fuel combines with oxygen at elevated temperatures. Nitrogen dioxide acts as an acute irritant. Some increase in bronchitis in children has been observed at concentrations below 0.01 ppm. In combination with hydrocarbons, oxides of nitrogen react in the presence of sunlight to form photochemical smog or ozone. Nitrogen dioxide absorbs visible light and, at a concentration of 0.25 ppm, will cause appreciable reduction in visibility.

Formation of nitrogen oxides occur at temperatures not normally found in prescribed fires. Some oxides of nitrogen may be formed at lower temperatures in the presence of free radicals, and nitrogenous compounds in forest fuels are another possible source. Generally, wildland fire is considered an insignificant contributor of these emissions.

Lead

The principal source of lead emissions is the combustion of gasoline containing lead alkyl additives. Since use of leaded gasoline has decreased dramatically, lead air pollution is rarely a problem anymore.

Lead particles that have been deposited on vegetation over decades can become re-emitted if the vegetation is burned. This phenomenon was documented during chaparral burning which took place east of the Los Angeles basin.